



**Tishk International University
Faculty of Applied Science
Department of Nutrition & Dietetics
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General Chemistry

Exp. 5: Titration of Vinegar

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Objectives

- To determine the molarity and percent by mass of acetic acid in vinegar.





Vinegar is essentially a solution of acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$) in water. The concentration of acetic acid in vinegar may be expressed as a molarity (in mol/L).

$$\text{Molarity} = \frac{\text{Moles of Acetic Acid}}{\text{Volume of Vinegar (in L)}}$$

or as mass percent

$$\text{Mass \%} = \frac{\text{Mass of Acetic Acid}}{\text{Mass of Vinegar}} \times 100$$



- In this experiment, a technique known as a **titration** will be used to determine the concentration of acetic acid in vinegar.
- A titration involves performing a controlled reaction between a solution of known concentration (**the titrant**) and a solution of unknown concentration (**the analyte**).
- The titrant is an aqueous solution of ~ 0.1 M sodium hydroxide (NaOH) and the analyte is vinegar. When mixed, a neutralization reaction occurs between sodium hydroxide and the acetic acid in vinegar.





- The sodium hydroxide will be gradually added to the vinegar in small amounts from a burette.
- A burette is a device that allows the precise delivery of a specific volume of a solution. The NaOH will be added to the vinegar sample until all the acetic acid in the vinegar has been exactly neutralized.
- At this point the reaction is completed, and no more NaOH is required. This is called the equivalence point of the titration.



- In order to know when the equivalence point is reached, an indicator solution called phenolphthalein is added to the vinegar at the beginning of the titration.
- Phenolphthalein is a pH sensitive organic dye. Phenolphthalein is colorless in acidic solutions like vinegar, and deep pink in basic solutions like sodium hydroxide.
- At the equivalence point of the titration, just one drop of NaOH will cause the entire solution in the Erlenmeyer flask to change from colorless to a very pale pink.



In acidic solution



In basic solution



equivalence point



- As the titration is performed, the following data will be collected:
- The molarity of NaOH (aq) used
- The volume of NaOH (aq) used to neutralize the vinegar
- The volume of vinegar used. Using this data, the molarity and mass percent of acetic acid in vinegar can be determined

Experimental Procedure

Materials and Equipment:

- 50-mL burette
- 5-mL volumetric pipette
- pipette bulb
- ~ 0.1 M NaOH (aq)
- vinegar
- phenolphthalein
- burette stand
- two 250-mL (or 125 mL) Erlenmeyer flasks
- wash bottle
- with distilled water,
- funnel.





Safety

- Be especially careful when handling the sodium hydroxide base (NaOH), as it is **corrosive** and can cause chemical burns to the skin.
- If any NaOH spills on you, rinse immediately under running water for up to 15 minutes and report the accident to your instructor. Make certain to wear safety glasses when handling NaOH when doing the experiment

Titration Procedure

1. Collect a 50-mL burette, 5-mL volumetric pipette, and pipette bulb.
2. Set up the burette and obtain NaOH solution.
3. Rinse the burette with ~5 mL NaOH; swirl and drain through the tip.
4. Fill the burette with NaOH (between 0–5 mL mark) using a funnel.
5. Flush the burette tip (ask instructor for guidance).
6. Record the **Initial Burette Reading** and **NaOH molarity** from the stock bottle.



Preparing the vinegar sample

- Rinse the volumetric pipette with distilled water, drawing above the 5-mL mark and draining through the tip. Repeat if needed.
- Do a final rinse with vinegar.
- Use the pipette to transfer **5.00 mL of vinegar** into a clean 250-mL Erlenmeyer flask.
- Record the vinegar volume.
- Add ~20 mL of distilled water and 2–3 drops of phenolphthalein to the flask.



Performing the titration

The titration steps:

1. Slowly add NaOH from the burette to the vinegar while swirling the flask.
2. As pink color persists longer, slow down and add NaOH drop by drop.
3. Stop when a pale pink color remains after swirling — this is the **equivalence point**.
4. Record the **Final Burette Reading**.
5. Refill burette and repeat titration for a second and third vinegar sample.
 - No need to flush the tip again.
 - Refill only if needed for third trial.
 - Clean and reuse an Erlenmeyer flask if necessary.
6. Take turns with your partner(s).
7. Dispose of chemical waste as instructed.



Calculations

Molarity of Acetic Acid in Vinegar

1. First, using the known molarity of the NaOH (aq) and the volume of NaOH (aq) required to reach the equivalence point, calculate the moles of NaOH used in the titration.
2. From this mole value (of NaOH), obtain the moles of $\text{HC}_2\text{H}_3\text{O}_2$ in the vinegar sample, using the mole-to-mole ratio in the balanced equation.
3. Finally, calculate the molarity of acetic acid in vinegar from the moles of $\text{HC}_2\text{H}_3\text{O}_2$ and the volume of the vinegar sample used.

